


Commercial Regulatory Authority (2010): Regulations for International Truck Transportation - Interpretation and Handling. Mr. Lieb (Gewerbeaufsichtsamt Oberbayern), Interview from 05.02.2010.


**Federal Ministry for Labor and Social Affairs, Germany (2009):** Arbeitszeitgesetz from 22.09.2009.  


http://www.kba.de/ch_005/nn_124592/DE/ZentraleRegister/EGKontrollgeraet/Karten/karten_node.html?__nn=true, last viewed: 03.08.2010.


Appendix
Appendix

A  Pseudocode of MNS Improvement Neighborhoods

01: Refresh Tabu List according to actual system time
02: Calculate decreasing cost ranking for all vehicle tours
03: WHILE (simulation_time < t_fixtime) {
04:    Identify feasible pair of vehicles for neighborhood operation, preferably a combination of a
05:    'cheap' and an 'expensive' vehicle tour, taking into account the Tabu list
06:    -> vehicle_a and vehicle_b
07:    Determine the exchangeable requests for vehicle_a and vehicle_b
08:    -> exchangeable_req_a and exchangeable_req_b
09:    Calculate the initial cost for the tours of vehicle_a and vehicle_b
10:    -> initial_cost
11:    Set best_cost = 999 999 999; best_tourroute_a = NULL; best_tourroute_b = NULL
12:    FOR (i=0; i<exchangeable_req_a; i++) {
13:        FOR (j=0; j<exchangeable_req_b; j++) {
14:            IF (request_i is compatible with vehicle B && request_j is compatible with vehicle A) {
15:                Extract requests i and j from the tours of vehicle_a and vehicle_b, respectively
16:                Apply Best-Reinsertion for request i into tour B
17:                Apply Best-Reinsertion for request j into tour A
18:                Calculate the new cost for the tours of vehicle_a and vehicle_b
19:                -> new_cost
20:                IF (new_cost < best_cost) {
21:                    best_cost = new_cost
22:                    best_tourroute_a = new tour of vehicle A
23:                    best_tourroute_b = new tour of vehicle B
24:                }
25:            }
26:        }
27:    }
28:
29:    FOR (i=0; i<exchangeable_req_a; i++) {
30:        IF (request_i is compatible with vehicle B) {
31:            Extract request_i from the tour of vehicle_a
32:            Apply Best-Reinsertion for request_i into tour B
33:            Calculate the new cost for the tours of vehicle_a and vehicle_b
34:            -> new_cost
35:            IF (new_cost < best_cost) {
36:                best_cost = new_cost
37:                best_tourroute_a = new tour of vehicle A
38:                best_tourroute_b = new tour of vehicle B
39:            }
40:        }
41:    }
42:
43:    FOR (j=0; j<exchangeable_req_b; j++) {
44:        IF (request_j is compatible with vehicle A) {
45:            Extract request_j from the tour of vehicle_b
46:            Apply Best-Reinsertion for request_j into tour A
47:            Calculate the new cost for the tours of vehicle_a and vehicle_b
48:            -> new_cost
49:            IF (new_cost < best_cost) {
50:                best_cost = new_cost
51:                best_tourroute_a = new tour of vehicle A
52:                best_tourroute_b = new tour of vehicle B
53:            }
54:        }
55:    }
56:    IF (best_cost < initial_cost) {
57:        Set tour of vehicle A = best_tourroute_a
58:        Set tour of vehicle B = best_tourroute_b
59:    }

Table 1: Pseudocode: λ-1 interchange (neighborhood I)
01: Calculate decreasing cost ranking for all vehicle tours
02: WHILE (simulation_time < t_fixtime) {
03:   Choose a vehicle, according to decreasing cost ranking
04:   -> current_vehicle
05:   Determine the exchangeable requests for current_vehicle
06:   -> exchangeable_requests
07:   Calculate the initial cost for the tour of current_vehicle
08:   -> initial_cost
09:   Extract the exchangeable requests from the vehicle's tour
10:   -> extracted_tour
11: Generate all sequence permutations for possible re-insertion of the exchangeable requests
12:   -> permutations
13:   Set best_cost = initial_cost; best_tourroute = initial_tourroute
14:   FOR (i=0; i<permutations; i++) {
15:     Apply Best-Reinsertion of exchangeable_requests into extracted_tour
16:     in the sequence of permutation i
17:     -> new_tour
18:     Calculate the cost for new_tour of current_vehicle
19:     -> new_cost
20:     IF (new_cost < best_cost) {
21:       best_cost = new_cost;
22:       best_tourroute = new_tour
23:     }
24:   }
25:   Set tour of current_vehicle = best_tourroute
26: }

Table 2: Pseudocode: intraroute optimal sequence (neighborhood II)

01: Calculate the current plan's objective value
02: -> initial_objective
03: Duplicate the current plan for back-up
04: -> initial_solution
05: Calculate decreasing cost ranking for all vehicle tours
06: Initialize a list all_exchangeable_requests
07: WHILE (simulation_time < t_fixtime) {
08:   FOR (i=0; i<number_of_vehicles; i++) {
09:     Choose most expensive vehicle, according to decreasing cost ranking
10:    -> current_vehicle
11:    Determine exchangeable requests for current_vehicle
12:    -> exchangeable_requests
13:    Append exchangeable_requests to the list all_exchangeable_requests
14:    Extract exchangeable_requests from current_vehicle's tour
15:   }
16:   WHILE (size_of_all_exchangeable_requests > 0) {
17:     Remove first request of all_exchangeable_requests
18:     -> first_request
19:     Apply Best-Reinsertion for first_request over all vehicle tours
20:   }
21:   BREAK
22: }
23: IF (Re-Insertion of all extracted requests was successful) {
24:   Calculate the new plan's objective value
25:   -> new_objective
26:   IF (new_objective > initial_objective) {
27:     Reconstruct initial_solution
28:   }
29: }
30: ELSE {
31:   Reconstruct initial_solution
32: }

Table 3: Pseudocode: complete solution rebuild (neighborhood III)
Appendix B Parameterization - Detailed Results

Appendix B contains the detailed planning results of the parameterization process in Section 5.5.1. The adapted MNS procedure is applied to the real-life test scenario.

<table>
<thead>
<tr>
<th></th>
<th>empty travel time</th>
<th>delay</th>
<th>break/wait</th>
<th>operating time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>penalty cost “delay”</th>
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<tbody>
<tr>
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Table 4: Parameterization of penalty costs (simulation speed $s = 5$, improvement neighborhoods I:II 66:33, anticipation horizon 10 min) - Detailed Results (in hours)

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</table>

Table 5: Parameterization of penalty costs (simulation speed $s = 1$, improvement neighborhoods I:II 66:33, anticipation horizon 10 min) - Detailed Results (in hours)
### Table 6: Parameterization of anticipation horizon (simulation speed s = 5, improvement neighborhoods I:II 66:33, penalty costs (30,5)) - Detailed Results (in hours)

<table>
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<th>anticip. horiz.</th>
<th>empty traveling</th>
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<th>break/wait</th>
<th>operating time</th>
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<td>10 min</td>
<td>24246</td>
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<td>485496</td>
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<td>30 min</td>
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<td>120 min</td>
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### Table 7: Parameterization of anticipation horizon (simulation speed s = 1, improvement neighborhoods I:II 66:33, penalty costs (30,5)) - Detailed Results (in hours)

<table>
<thead>
<tr>
<th>%I -%II</th>
<th>empty traveling</th>
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<th>break/wait</th>
<th>operating time</th>
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### Table 8: Parameterization “allocation of improvement time” (simulation speed s = 5, anticipation horizon 10 min, penalty costs (30,5)) - Detailed Results (in hours)

<table>
<thead>
<tr>
<th>%I -%II</th>
<th>empty traveling</th>
<th>delay</th>
<th>break/wait</th>
<th>operating time</th>
</tr>
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### Table 9: Parameterization “allocation of improvement time” (simulation speed s = 1, anticipation horizon 10 min, penalty costs (30,5)) - Detailed Results (in hours)